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MICROWAVE VERSUS RECON-O-STAT™ FOR PREPARATION OF TECHNETIUM-99M-SESTAMIBI: A COMPARISON OF HAND EXPOSURE, RADIOCHEMICAL PURITY AND IMAGE QUALITY

To the Editor: We read with interest the article by Porter and Karvelis (*1*) regarding the use of the Recon-o-Stat™ thermal controller (model DMP150, DuPont Pharma, Billerica, MA) to prepare ^{99m}Tc-sestamibi. In comparison with the microwave oven heating method (*2–4*), the authors concluded that the Recon-o-Stat method significantly reduced the hand exposure to the preparer of Cardiolite® (DuPont Merck Pharmaceutical Co., Billerica, MA) (*1*). Due to the fact that the Recon-o-Stat method does not require the reaction vial to be taken out of the tungsten vial shield during the 10-min heating and cooling cycle period, the radiation exposure to the hands of the preparer undoubtedly would be lower than with the other methods (e.g., microwave oven heating, boiling water bath and heating block), which all require some hand maneuvering of the ^{99m}Tc-sestamibi vial. Since the microwave oven heating method involves more handling of the vial with the hands (i.e., attachment and removal of the styrofoam cover, placement and retrieval of the vial in a screw-cap plastic container), finger exposure using the microwave heating method would probably be the highest.

Radiation Exposure versus Clinical Benefits

However, the use of a microwave oven in the preparation of ^{99m}Tc-sestamibi should not be discouraged by this report. Technetium-99m-sestamibi is very useful to quantify the amount of myocardium at risk in patients with an acute myocardial infarct and to assess myocardial salvage following percutaneous transluminal coronary angioplasty and/or thrombolysis. In these acute situations, the 10–13-sec microwave oven heating method (*2–4*) does provide a fast and cost-effective preparation method for emergency use of ^{99m}Tc-sestamibi without the need for advance preparation of multiple kits each day. Although ^{99m}Tc-sestamibi vial breakage has been reported during the microwave heating process (*5*), the improved cushioned packaging with a foam insert in each Cardiolite kit (*6*) seems to help solve the problem of vial breakage attributed to pre-existing microscopic impact flaws on the glass vial. If one is still concerned about the potential for vial breakage during the microwave heating procedure, an alternative method for the rapid preparation of ^{99m}Tc-sestamibi has been developed in our laboratory (*7*). Technetium-99m-sestamibi can be quickly prepared with a 2-min incubation in an insulated beaker filled with hot water from an instant hot water machine (*7*). As with the other preparation methods (e.g., boiling water bath, heating block and microwave oven heating methods), the instant hot water method would also have a higher hand exposure to the operator when compared to the Recon-o-Stat method (*1*). It would be interesting to see the comparison of hand exposure between the Recon-o-Stat method and the other non-microwave heating methods (i.e., the standard boiling water bath method (*8*) and the other two alternative methods: heating block and instant hot water methods).

Heating Temperature versus Radiochemical Purity

As shown in the study by Porter and Karvelis, the immediate and 24-hr radiochemical purity (RCP) values of ^{99m}Tc-sestamibi prepared by the Recon-o-Stat method were significantly lower than the microwave RCP values (*1*). Some of the 24-hr Recon-o-Stat RCP values were below the recommended 90% acceptance limit (*8*), whereas all of the measured 24-hr microwave RCP values maintained at an average of 97.3 ± 1.1% (*1*). Since ^{99m}Tc-sestamibi can be used within 6 hr post-preparation (*8*), it is essential to determine whether the Recon-o-Stat ^{99m}Tc-sestamibi preparation that has a borderline immediate RCP value (i.e., 90–92%) will sustain a passing RCP value (i.e., ≥90%) throughout the entire 6-hr shelf life. As stated in the package insert for Cardiolite (*8*), ^{99m}Tc-sestamibi preparation with an RCP value of at least 90% has been proven to be safe and effective in the previous clinical trial. Nevertheless, one should always try to provide patients with the radiopharmaceutical that has the highest achievable RCP value in order to minimize the amount of undesirable radiochemical impurities to the patient. This would not only reduce unnecessary radiation exposure to the patient, but would also decrease any interference with image interpretation caused by radioactive impurities. Both the recommended boiling water bath method (*8*) and the microwave oven heating method (*2–4*) consistently produce the highest ^{99m}Tc-sestamibi RCP value (*1–4*).

Although the package insert for Cardiolite does not contain any specific restrictions with regard to the use of a first eluate from a long in-growth-time generator (i.e., Monday generator) to reconstitute the kit (*8*), one Recon-o-Stat kit prepared with such an eluate resulted in an RCP value of 82.5% (*1*). In the comparison study by Porter and Karvelis (*1*), a substantially higher amount of ^{99m}Tc activity was used in the reconstitution of the Cardiolite kit (i.e., 22.2 GBq, 600 mCi versus the standard 5.55 GBq, 150 mCi (*8*)). A similar observation was noted in our previous report (*9*). We have found that the use of old (i.e., >6 hr post-elution) eluate from a long-ingrowth generator in the preparation of a ^{99m}Tc-sestamibi kit is associated with a high rate of kit failure (i.e., RCP value <90%). Higher failure rates of the ^{99m}Tc-sestamibi kit are noted especially when higher activities of ^{99m}Tc eluate are used to reconstitute the Cardiolite kit (*9*).

According to the specifications for the Recon-o-Stat thermal controller (*10*), the thermal range of this Peltier heat pump is 0–119°C with a programmed target temperature set at 119 ± 0.7°C. This temperature is clearly much higher than the water temperature in the boiling water

bath, which is the recommended method for the preparation of ^{99m}Tc-sestamibi (*8*). It is not clear why, with this high temperature (i.e., 119 ± 0.7°C), the Recon-o-Stat RCP values were consistently at the low end, with occasional failing RCP values (i.e., <90%) (*1*). Gagnon, et al. have demonstrated that a 1-min boiling water bath time is sufficient to provide an RCP value of 99.7 ± 0.3% (*2*). We have shown that, even with a 2-min incubation of a ^{99m}Tc-sestamibi kit in an 82.2°C water bath, an acceptable RCP value of 94.1 ± 0.7% can be obtained over 24 hr after preparation (*7*).

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Reply: We agree with Drs. Hung and Gibbons that more rapid preparation methods of ^{99m}Tc-sestamibi should not be discarded entirely. On rare occasions we still employ the microwave method when speed is our primary concern. Whereas speed is critical when performing ictal SPECT studies with cerebral perfusion agents, a relatively large window generally exists for the preparation/administration of myocardial perfusion agents even in the acute setting.

A comparison of finger TLD readings of those involved with ^{99m}Tc-sestamibi preparation in our lab for the 6-mo periods 8/94–1/95 (microwave) and 8/95–1/96 (Recon-o-Stat™) reveals a reduction of approximately 22%. Adjusted for the fraction represented by ^{99m}Tc-sestamibi of the approximate total activity handled, this is consistent with the reduction attributed to the use of the Recon-o-Stat projected from our published data. Additionally, the magnitude of finger radiation dose reduction which we reported in comparison with the microwave would be expected to be fairly consistent regardless of which other unshielded method is employed.

Vastly improved packaging has obviously reduced the likelihood of vial damage during shipping. However, glass imperfections and other variations in vial thickness do occur and must still be considered as a potential risk for vial rupture. We have observed variations in the depth of the aluminum closure crimp and can confirm an isolated instance of the stopper blowing-off when microwaved.

Although the Recon-o-Stat specifications indicate an accuracy of "±0.7°C of programmed target at 119°C" (*1*), the manufacturer confirms that when the kit is prepared at the recommended volume, the maximum internal vial temperature is only 85°C (DuPont Pharma technical services, Billerica, MA, *personal communication*), thereby subjecting the vial to significantly less internal pressure than other methods.

Clearly, the radiochemical purity was consistently lower with the Recon-o-Stat, however, the only instance we observed purity to be <90% was the one we reported. We have used initial elutions at the manufacturer's recommended activities without similar problems, which is apparently why this is not contraindicated in the package insert.

In summary we feel that: (a) ultrafast preparation methods do not enhance diagnostic accuracy and are simply not necessary in the overwhelming majority of conventional and acute Cardiolite® administrations and (b) the routine use of methods which require unshielded transfers should be discouraged from a radiation safety perspective.

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